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Hirudinea from the Apolobamba in the Bolivian Andes, Including Three New Species of *Helobdella* (Clitellata: Hirudinea)

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ABSTRACT

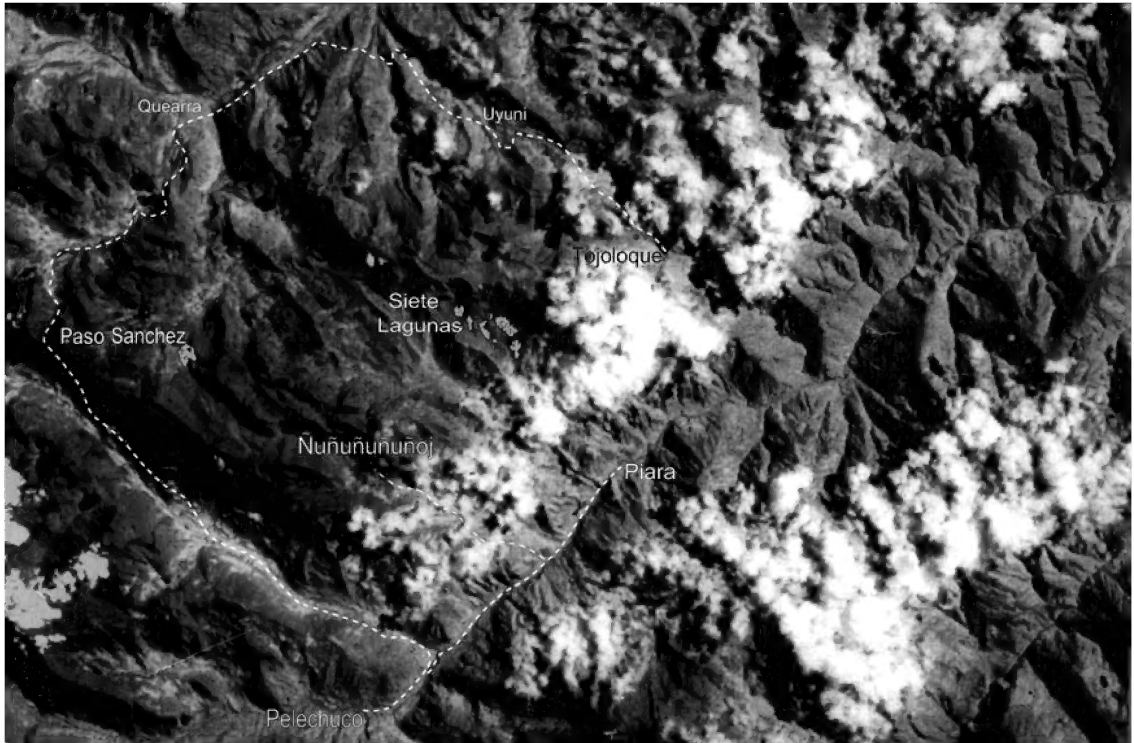
Four species of leeches were found in the Apolobamba Range of the Bolivian Andes. Collections were made from 4100 m down to 2820 m—among the highest collecting localities ever for leeches. There were three new species in the genus *Helobdella* including *Helobdella ringueleti*, *Helobdella nunununojensis*, and *Helobdella sorochi*, as well as one representative of *Cylicobdella coccinea*. One of the new species exhibited an attitude of parental care unique among glossiphoniids in that the brood was enclosed within two halves of the folded parent. None of these species is known to be sanguivorous.

INTRODUCTION

Some collections of leeches from South America early in the 20th century were from high altitudes in the Andes. Professor Fuhrmann of the University of Neuchâtel furnished Weber (1913) with specimens found above 1800 m in Colombia, the highest, *Blanchardiella columbiensis* at 3800 m. Thereafter Weber (1916b) described four new species of *Helobdella* from Lagunas Naticocha, Lavandera, and Huaron in the vicinity of Cerro de Pasco in Peru at 5140 m.

Since that time, Andean leeches found at high altitudes have continued to be *cylicobdellids* or nonsanguivorous *glossiphoniids*. The highest among these are *Cylicobdella coccinea* at 4100 m near Huaron, Peru (Ringuelet, 1960) and at 4100 m from the Mucuchíes desert near Lake Mucubají, Venezuela (Ringuelet, 1981), *Blanchardiella octoculata* at 4150 m near Santa Isabel, Columbia (Ringuelet, 1980a), *Helobdella titicacensis* (Ringuelet, 1959) in Lake Titicaca, and *Maiabdella batracophila* (Ringuelet, 1980b).

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Map 1. Satellite image of the Apolobamba region and collection localities (see figs. 1–4) marked with the joint American Museum Center for Biodiversity and Conservation/Colección Boliviana de Fauna 1999 expedition routes (dashed lines).

In his doctoral thesis Weber (1915) wondered, “Qui sait si les régions montagneuses de l’Équateur, du Pérou ou de la Bolivie, explorées scientifiquement, ne nous fourniront pas d’intéressants espèces . . . ?” Remarkably, though several species were described from Andean Peru the next year (Weber, 1916a, 1916b), Bolivia has remained unexplored. The only accounts of Bolivian leeches to date are Ringuet’s (1953) identification of four specimens mailed from Cochabamba (2570 m) and Siddall’s (2001) brief collections at Laguna Volcan (1100 m).

On 17 October 1999 a team of researchers from the American Museum of Natural History, the Colección Boliviana de Fauna, and the Museo de Historia Natural Noel-Kempff Mercado, sponsored by the Center for Biodiversity and Conservation of the American Museum of Natural History, embarked on faunistic survey expeditions in the high Andean portion of Bolivia (map 1). From 19 October 1999 through 26 October 1999, col-

lections were conducted at elevations between 3500 m and 4700 m in two adjacent valleys (Tojoloque and Qanchis Qocha) above the tree line. From 29 October 1999 through 4 November 1999 collections were made between 2800 m (at the junction of Valle Qanchis Qocha and Valle Pelechuco in a dense cloud forest) and 3900 m (Pusu Punku).

MATERIALS AND METHODS

Leeches were collected in Valle Tojoloque (fig. 1), Qanchis Qocha (fig. 2), Pusu Punku (fig. 3), and Piara (fig. 4) all in the vicinity of the boundary between the Ulla Ulla National Fauna and Biosphere Reserve and Madidi National Park, Departamento La Paz, Bolivia near the Peruvian border. This region, near the villages of Pelechuco and Quearra, is part of the Apolobamba range of the Cordillera Occidental o Real and consists of a parallel series of steep valleys each of



Figs. 1–4. Collection localities in the Apolobamba range. **1.** Valle Tojoloque (looking west) with locality UU99–6 (lower arrow) and UU99–11 (upper arrow) at 3750 m and 3860 m, respectively. **2.** Qanchis Qocha or Siete Lagunas (looking southeast) and collection sites (arrows) for UU99–20 at 4050 to 4100 m. **3.** Pusu Punku (looking west) and site UU99–40, Ñuñuñuñuñoj (arrow) at 3870 m. **4.** View northeast down the steep walled Rio Pelechuco Valley toward Piara at 2820 m (arrow).

which is roughly perpendicular to the Rio Pelechuco flowing northeast toward the Tui-chi, the Beni, and eventually the Amazon.

Leeches were collected by examining the underside of submerged or semisubmerged rocks, and by dip-netting of sediment in any freshwater pools or streams encountered. Leeches were relaxed with the gradual addition of 50% ethanol and fixed either in 95% ethanol or in 10% formalin. Examination of external morphology and dissections were accomplished with a Nikon SMZ-U stereo microscope with a SPOT-RT digital camera. Specimens prepared for histology were dehydrated through ethanol, cleared with Hemo-D, and infiltrated with Paraplast Plus in a Tissue Tek II tissue processor. Longitudinal sections (5 μ m) were stained with Haematoxylin and Eosin/Phloxine and examined with an Olympus BX50 compound microscope at low power.

RESULTS

Aquatic leeches were encountered only at the highest altitudes examined where the terrain was of a sufficiently shallow grade to permit the collection of daily precipitation into pools or lakes. Deeper in the Rio Pelechuco Valley (i.e., at Piara) aquatic leeches were absent in the swiftly flowing rivers and cataracts, though one terrestrial leech was found. At the higher elevations, the landscape was dominated by terrain that is regularly burned to clear ground-dwelling bromeliads from pasture land. Here, each laguna was fed strictly by rain or snow-melt. In Tojoloque it was clear that the two lagunitas containing leeches had neither inlet nor outlet for water flow and presumably maintain their levels by the daily clouds and rains that sweep up from the east. Water in the lakes of Qanchis Qocha and in the bofedales of

upper Pusu Punku readily flowed out of these valleys and into the Rio Pelechuco below. The vicinity of Piara (a series of ruins that once was a village on the Incan road between Pelechuco and Apolo) is primarily dense cloud forest in steep valleys dominated by bamboo, legumes and associated bromeliads where it has not been burned and cleared for subsistence farming or grazing of cattle. All of the leeches found at higher elevations (3750 m through 4100 m) can be placed in three new species of *Helobdella*.

ORDER RHYNCHOBDELLIDA
BLANCHARD, 1894

FAMILY GLOSSIPHONIIDAE VAILLANT, 1890

Helobdella ringueleti, new species

Figures 5–15

HOLOTYPE (figs. 5–7, 9, 10): Free-living from pond above cataract (fig. 1) in Valle Tojoloque at 3860 m, in Madidi National Park, Departamento La Paz, Bolivia, 14°44'30"S, 69°01'26"W, 21 October 1999, station number UU99–11, hand collected by M. Siddall; (deposited in Coleccion Boliviana de Fauna, La Paz, Bolivia, uncataloged); body length 33.8 mm, maximal width 5.7 mm, fixed in 10% formalin, stored in 70% ethanol.

PARATYPES (figs. 8, 11–15): One dissected adult and 3 juveniles taken from venter of the dissected adult both fixed in 95% ethanol from same locality UU99–11 as above, hand collected by M. Siddall on 23 October 1999, (AMNH 4230, Annelida, and AMNH 4231, Annelida). One juvenile also fixed and stored in 95% ethanol held at –80°C (AMNH 100948, Frozen Tissue Collection).

FORM (figs. 5–10): Body robust and lanceolate, broadest in posterior half; somites I through VI a2 demarcated in some adults (fig. 7); somites I–IV uniannulate, V biannulate, VI–XXV triannulate, XXVI biannulate, and XXVII uniannulate but broad; all annuli from VII a1 through XXVII subdivided dorsally (fig. 9) though less regularly ventrally; dorsum convex, without papillae; venter flat to slightly convex, never concave, without papillae; anterior sucker triangular to ovoid (fig. 6); mouth pore large subterminal, not central; caudal sucker circular, concave, directed subterminal in relaxed state, approx-

imately same width as posterior somites; middorsal nuchal glands (fig. 7) at VIII a1/a2 with tawny-brown secretion, chitinoid scute absent or at least not pronounced, nuchal glands not obvious in juveniles.

EYES (figs. 7, 8): One pair, punctiform, well separated, in III.

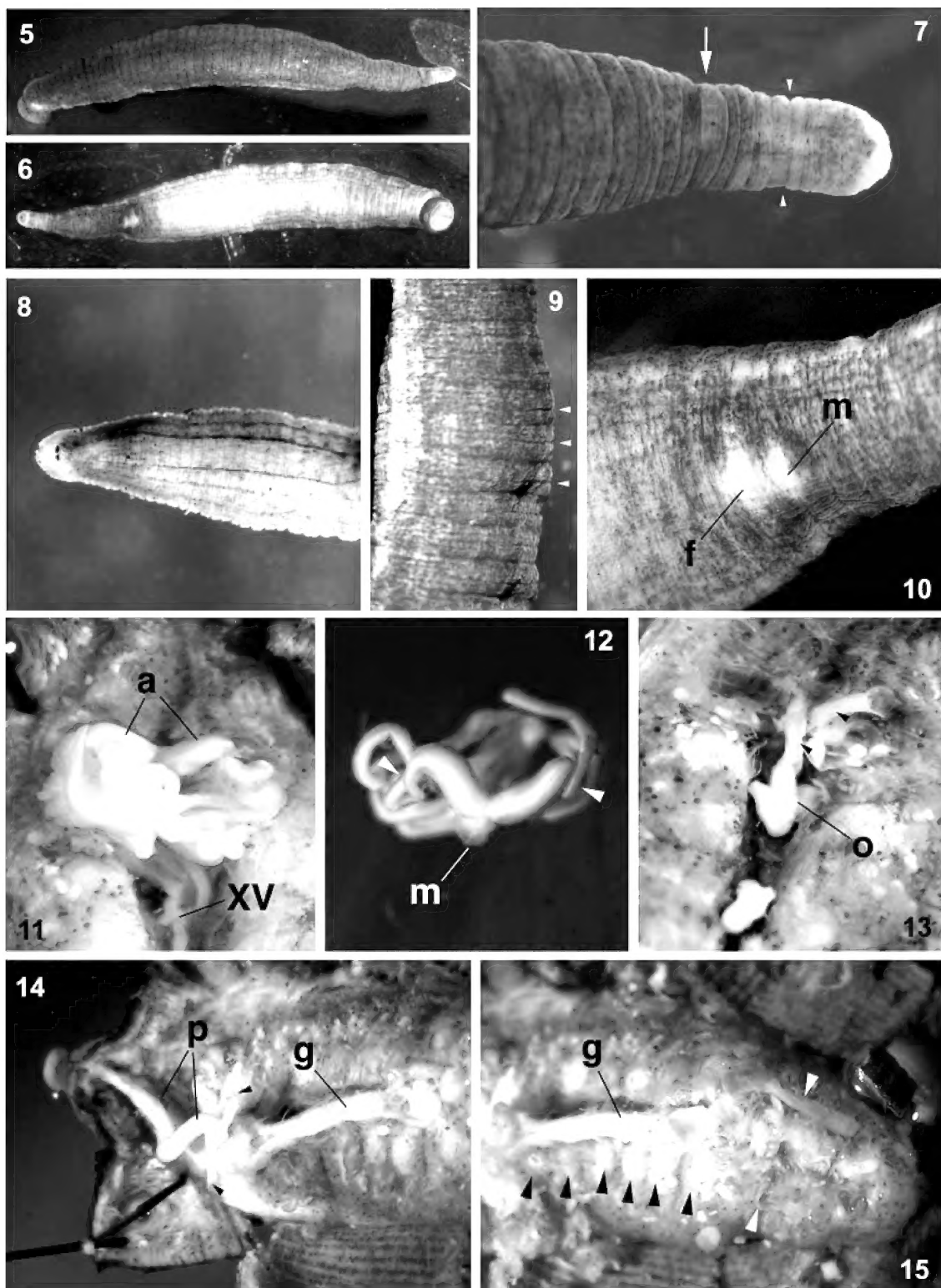
COLOR AND PATTERN (figs. 5–10): Anterior margin of oral sucker (I, II) unpigmented; dorsum gray to light brown with randomly arranged chromatophores; three pairs of fine supramarginal lines (fig. 8) dorsally from VIII through XXIV or XXV, most obvious in juveniles; venter lighter than dorsum in postgenital somites; three pairs of fine infamarginal lines (figs. 6, 10) from VIII through XXIV or XXV corresponding to those seen dorsally. Caudal sucker evenly pigmented.

REPRODUCTIVE SYSTEM (figs. 10–15): Male and female gonopores separated by one annulus (fig. 10), male at XII a1/a2, female at XII a2/a3; six pairs of testisacs (fig. 15) at XIII/XIV through XVIII/XIX; sperm ducts highly convoluted in XIV and XV (fig. 11), atria piriform directed laterally (figs. 11, 12), sperm ducts empty into atria anterioventrally with preatrial cornua (fig. 12); ovisacs short, in XII only, and folded (fig. 13).

ALIMENTARY TRACT (figs. 14, 15): Proboscis in membranous sheath and very long, base at XIV/XV and coiled when retracted (fig. 14); salivary cells arranged diffusely in parenchyma, ductules of the latter forming a bundle inserting into the base of the proboscis; oesophagus simple, not recurved; no gastric chambers or digitiform caeca in midbody somites, only postcaeca (diverticula) from XIX through XXIV (fig. 15); intestine from XIX/XX with four lobes; anus at XXVI/XXVII.

ETYMOLOGY: Named for Raul Ringuelet of the Museo de La Plata, Argentina, who contributed impressively to our knowledge of South American leeches from 1936 through 1986, in particular describing or redescribing approximately half of the known species of *Helobdella*. The species name should be pronounced rin-geh-let-eye.

REMARKS: There are seven species of *Helobdella* in South America possessing the "chitinoid" plaque at VIII a1/a2: *Helobdella scutifera* (see Blanchard, 1900), *Helobdella simplex* (see Moore, 1911), *Helobdella festai*



exhibited a swelling on VIII a1 (fig. 20). Histological sectioning revealed a muscularized pad in the middorsal region of VIII a1 but no glandular tissue whatsoever.

EYES (fig. 20): One pair, punctiform, well separated, at II/III.

COLOR AND PATTERN (figs. 16–20): Dorsum with irregular longitudinal arrays of gray to brown chromatophores but no definite lines or bands. Venter much lighter with irregularly arranged chromatophores on either side of the midline.

REPRODUCTIVE SYSTEM (figs. 19, 21): Male and female gonopores separated by one annulus, male at XII a1/a2, female at XII a2/a3; six pairs of testisacs at XIII/XIV through XVIII/XIX; sperm ducts reach to XIX, atria piriform, directed anterolaterally, sperm ducts empty into atria dorsally; ovisacs straight and long, reaching to XVII.

ALIMENTARY TRACT (figs. 22, 23): Proboscis in membranous sheath, base at XIII; salivary cells arranged in a compact mass only in XXIII, ductules of the latter forming a bundle inserting into base of proboscis; oesophagus simple, not recurved; no gastric chambers or digitiform caeca in midbody somites; postcecae (diverticula) in XIX only (fig. 23); intestine from XIX/XX with four lobes; anus at XXVI/XXVII.

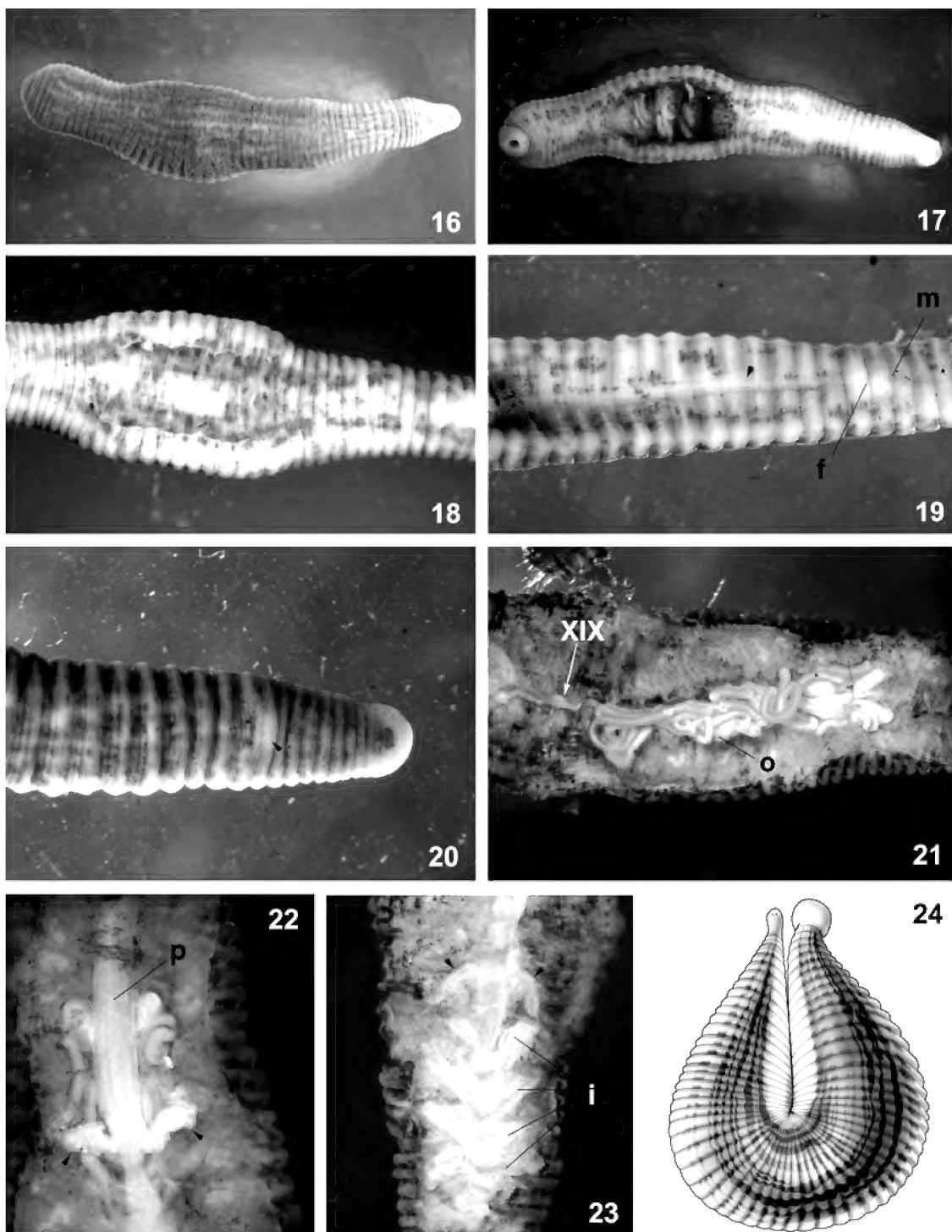
ETYMOLOGY: Reflects the type locality Ñuñuñuñuñoj (a Quechua placename, “The Place of Very Bare Breasts”, from Ñuñu meaning nipple), a bowl at the top of Valle Pusu Punku. The species name, thus, should be pronounced nyue-nyue-nyue-nyue-nyoe-hen-sis.

REMARKS: This species was found exhibiting a wholly unique brooding behavior (fig.

24) in that adults with eggs in various stages of development would invariably be folded in half so as to enclose their young. Moreover, this specialized brooding behavior is accompanied by a distinct broadening from XVI a3 through XX a3 where the eggs are held in a pocket on the venter (fig. 17). In adults that had eggs (as opposed to hatched juveniles) attached, there was a distinct trough in the ventral midline (fig. 19) running directly from the female gonopore to XVII. This groove also was visible histologically. It is tempting to think of it as a bowling lane for eggs being passed back to the brooding somites. The possession of the very pronounced sawtooth-like annuli is characteristic of *Helobdella godeti* and *Helobdella columbiensis*, both of which might be expected to occur in the area in as much as the former was discovered at 5140 m in Peru and the latter at 2400 m in Colombia (Weber, 1913, 1915, 1916a, 1916b). *Helobdella columbiensis* apparently resembles *Helobdella triserialis* in having very distinct lines on its dorsum. In addition, *H. columbiensis* has a long tapering “neck” between the clitellum and the cephalic somites and the oral sucker is reportedly exceedingly small (Weber, 1913, 1915). *Helobdella godeti*, which also has short postcaeca, nonetheless has the full six pairs of gastric caeca and a distinct chitinoid scute on VII a1, a2. The lack of gastric caeca and the presence of short postcaeca in XIX or XIX to XX is more a characteristic of *H. elongata*, *H. michaelseni*, *H. ampullariae*, and *H. similis* placed collectively in the genus *Gloiobdella* by Ringuelet (1978b; see also Sawyer, 1986). Much like *H. nununujensis*, *Helobdella michaelseni* and *H.*

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Figs. 5–15. *Helobdella ringueleti*, n. sp. **5.** Dorsal surface of the holotype. **6.** Ventral surface of the holotype. **7.** Cephalic region of the holotype showing constriction at VI a2/a3 (arrowheads) and nuchal gland at VII a1 (arrow). **8.** Anterior dorsal surface of a juvenile found attached to an adult. **9.** Dorsum of the holotype exhibiting subdivision of midbody annuli (arrowheads). **10.** Clitellar region of the holotype with male (m) and female (f) gonopores separated by one annulus. **11.** Male median reproductive apparatus with laterally deployed atria (a) and sperm ducts arranged in XIII and XIV. **12.** Male median reproductive apparatus dissected away from the adult and viewed from anterior to the male gonopore (m) illustrating the preatrial cornua (arrowheads) of the sperm ducts. **13.** Folded ovary (o) and thinner oviducts (arrowheads) in XIII. **14.** Anterior digestive system showing the long coiled proboscis (p), salivary ductules (arrowheads), and gastric tube lacking caeca (g). **15.** Posterior digestive system with unbranched gastric tube (g) and two postcaeca (white arrowheads); black arrowheads = testisacs.



Figs. 16–24. *Helobdella nunununojensis*, n. sp. **16.** Dorsal surface of the holotype. **17.** Ventral surface of the holotype with attached brood of hatchlings. **18.** Venter showing the broadened brood pouch from XVI through XX. **19.** Venter showing the male (m) and female (f) gonopores as well as

obscura have no caeca whatsoever, including no postcaeca (Blanchard, 1900; Weber, 1915; Ringuelet, 1944b), whereas *H. ampullariae* and *H. similis* do have postcaeca in XIX only (Ringuelet, 1942a, 1942b, 1945). These species, like *H. elongata* in North America, are completely colorless even when viewed live (Ringuelet, 1942a, 1942b, 1944a, 1944b, 1945). Moreover, both have their eyes situated on IV (i.e., on the fifth annulus), *H. ampullariae* has only four pairs of testisacs (Ringuelet, 1945) and the sperm ducts of *H. similis* reach only to XV/XVI, and both of these have diffuse salivary tissue. Perhaps the most similar known species is *Adaetobdella cryptica* (see Ringuelet, 1978b) in the genus Ringuelet erected for those species of *Helobdella* possessing compact salivary glands. Although the cream-colored *Adaetobdella cryptica* has the short postcaeca, its ovaries reach only XV and it possesses five pairs of testisacs whereas *H. nunununojen-sis* has the more typical six.

***Helobdella sorojchi*, new species**

Figures 25–35

HOLOTYPE (figs. 25, 30): Free-living under rocks along the shoreline of lakes in Qanchis Qocha (Siete Lagunas) at UU99–20 from 4090 to 4100 m, in Madidi National Park, Departamento La Paz, Bolivia, from 14°44'99"S, 69°02'22"W through 4°45'02"S, 69°02'2"W, 25 October 1999, hand collected by M. Siddall (deposited in Coleccion Boliviana de Fauna, La Paz, Bolivia, uncataloged); body length 11.2 mm maximum length in relaxed state, maximal width 3.5 mm, fixed in 10% formalin, stored in 70% ethanol.

PARATYPES: One dissected adult (AMNH 4236, Annelida), three adults (deposited in Coleccion Boliviana de Fauna, La Paz, Bolivia, uncataloged), and three additional adults (AMNH 4237, Annelida) with and

without broods all fixed in 10% formalin from same locality UU99–20 as above, hand collected by M. Siddall on 25 October 1999. Seven adults (deposited in Coleccion Boliviana de Fauna, La Paz, Bolivia, uncataloged), and six additional adults (AMNH 4238, Annelida) with and without broods all fixed in 95% ethanol from same locality UU99–20 as above, hand collected by M. Siddall on 25 October 1999. One adult fixed and stored in 95% ethanol held at –80°C (AMNH 100953, Frozen Tissue Collection).

FORM (figs. 25–30): Body thin and lanceolate, occasionally broadened from XVI a3 through XX a3 especially in live state; somites I–V uniannulate, VI–XXIV triannulate, XXV biannulate, XXVI and XXVII unianulate; dorsum convex, without papilla; venter flat to concave, without papillae; anterior sucker oval; mouth pore terminal (figs. 28, 29); annuli from VIII through XV weakly subdivided (fig. 30); caudal sucker circular, concave, directed subterminal to ventrad in relaxed state, approximately two-thirds of width of posterior somites. There is no chitinous scute and there are no visible glands. Internally this species has an unusually fibrous appearance due to a large amount of connective tissue.

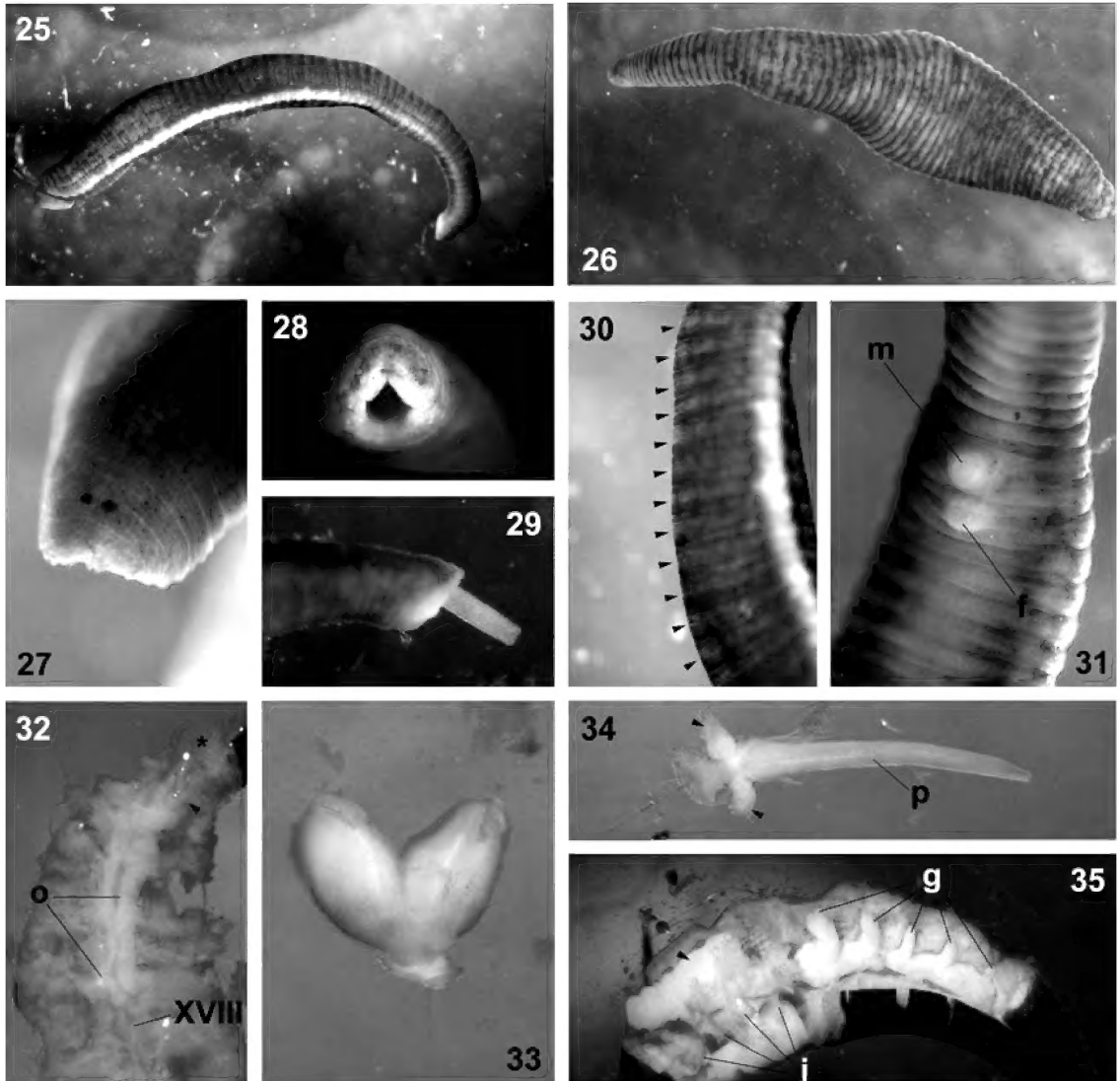
EYES (fig. 27): One pair, punctiform, well separated, at II/III.

COLOR AND PATTERN (figs. 25, 26, 31): Dorsum uniformly brown with fine paramedial and supramarginal longitudinal lines, others with irregular mottled brown chromatophores. Venter much lighter with smooth paramedial pigmentation.

REPRODUCTIVE SYSTEM (figs. 31–33): Male and female gonopores obvious and separated by one annulus, male at XII a1/a2, female at XII a2/a3; six pairs of testisacs at XIII/XIV through XVIII/XIX; sperm ducts and ovaries reach to XVII/XVIII, however ovaries lie dorsal to sperm ducts (fig. 32) as opposed to

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the central egg-bowling trough (arrowhead) exhibited by adults in the early stages of brooding. **20.** Anterior of an adult demonstrating the aglandular nuchal pad. **21.** Median reproductive apparatus with the tip of an oviduct (o) at XVII and the longer sperm ducts reaching XVIII/XIX. **22.** Anterior digestive system with the proboscis (p) having two glandular salivary masses (arrowheads) at its base in XIII. **23.** Posterior digestive system with the short postcaeca (arrowheads) in XIX only and the four pairs of intestinal caeca (i). **24.** Typical brooding attitude of this species.

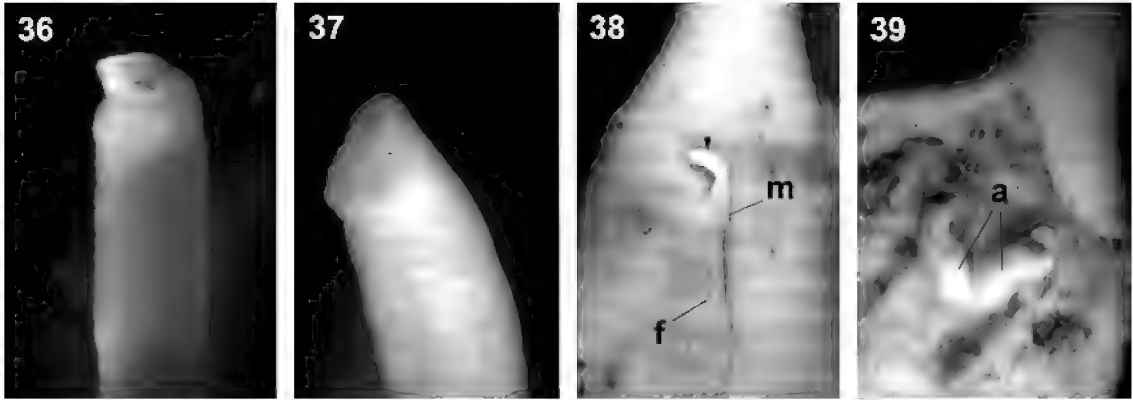


Figs. 25–35. *Helobdella sorojchi*, n. sp. **25.** Lateral view of the holotype with a finely striped surface. **26.** Dorsal surface of a paratype with a more speckled appearance. **27.** Cephalic region of an adult exhibiting eyes at margin of II/III. **28.** Anterior view of the oral sucker with terminal mouth pore on leading margin. **29.** Lateral view of a specimen with proboscis protruding from terminal mouth pore. **30.** Dorsal surface of the holotype showing weak subdivisions (arrowheads) of midbody annuli. **31.** Ventral surface of an adult with prominent male (m) and female (f) gonopores and paramedial pigmentation pattern. **32.** Median reproductive apparatus with the atria (*) removed, ovaries (o) extending to XVII/XVIII, and in which the descending sperm ducts (arrowhead) loop underneath the ovaries along the ventral muscle layer. **33.** Dorsoposterior view of male atria. **34.** Proboscis (p) and small compact salivary glands (arrowheads). **35.** Posterior digestive system with five gastric caeca (g) including large postcaeca (arrowhead) lateral to four pairs of intestinal caeca (i).

the ventral position more typical for the family. Atria piriform directed anteriorly, sperm ducts empty into atria dorsally (fig. 33).

ALIMENTARY TRACT (figs. 34, 35): Probos-

cis in membranous sheath, base at XIII; salivary cells arranged in a small compact mass only in XIII, ductules of the latter are very short; oesophagus simple, not recurved; six



Figs. 36–39. *Cylicobdella coccinea*. **36.** Cephalic somites viewed dorsolaterally. **37.** Caudal sucker. **Fig. 38.** Ventral surface with female (f) and male (m) gonopores and protruding penis (arrowhead). **39.** Male median reproductive apparatus including paired atria (a) and cornua.

gastric chambers with digitiform caeca in midbody somites including large postcecae (diverticula) from XIX through XXV; intestine from XIX/XX with four lobes; anus at XXVI/XXVII.

ETYMOLOGY: The name is Quechua and stems from the fact that these were found at 4100 m (among the highest collection localities for Andean leeches) after the collectors had to crest a 4700 m pass between Tojoloque and Qanchis Qocha, collect the specimens, and return in under seven hours. *Sorojchi* or *soroche* means “altitude sickness”. The species name should be pronounced soe-roe-chay.

REMARKS: Notwithstanding the variability in external pigmentation for this species, the internal anatomy was the same between speckled and striped varieties. In certain respects *H. sorojchi* resembles *H. nunununojensis*. Both are relatively long and thin leeches with widened somites from XVI through XX, with a subterminal to ventrally directed caudal sucker, a large terminal mouth pore, and eyes at II/III. *Helobdella sorojchi*, however is unique among leeches in having the ovaries overlying the sperm ducts. *Helobdella* species with subdivided annuli but without a nuchal scute or glands include *Helobdella cordobensis* (see Ringuelet, 1943), *Helobdella auricana* (see Ringuelet, 1978a), and *Helobdella longicollis* (see Weber, 1915). Weber’s (1915) figure of *H. longicollis*, however, shows a highly coiled proboscis and a very long thin neck with a

broader cephalic region, not unlike a piscicolid; and its gonopores are on the annuli, not in furrows. *Helobdella cordobensis* and *H. auricana* each have diffuse salivary tissue (Ringuelet, 1943, 1978a) and neither has the ovisacs overlying the descending portions of sperm ducts.

ORDER ARHYNCHOBDELLIDA
BLANCHARD, 1894

SUBORDER HIRUDINIFORMES
CABALLERO, 1952

FAMILY CYLICOBDELLIDAE RINGUELET, 1972

Cylicobdella coccinea Kennel, 1886

Figures 36–39

MATERIAL EXAMINED: One specimen free-living from Piara, Bolivia, approximately 14°47′74″S, 69°00′40″W, 2820 m, 4 November 1999, hand collected by Jaime Rodríguez, determination by M. Siddall. One specimen fixed in 95% ethanol, stored in 70% ethanol (deposited in Colección Boliviana de Fauna, La Paz, Bolivia, uncataloged). The separation of male and female gonopores by two and a half annuli, and a biannulate somite IV is consistent with descriptions for this species (Kennel, 1886; Ringuelet, 1972, 1980a, 1981).

DISCUSSION

The Andes appear to be marked by high local endemicity of helobdellid leeches, though cyclicobdellid species also appear to be widely distributed at these altitudes. The

discovery of four new species of *Helobdella* in a small region of lakes near Cerro de Pasco, Peru (Weber, 1916a) and now an additional three in a similarly small region of Bolivia some 750 miles to the south and east suggest that there may be many more taxa yet to be found at high altitudes. This is a somewhat unusual finding in that the Cordillera Real has experienced successive glaciation events from the Pleistocene through the Late Quaternary only 14,000 years ago (Gouze et al., 1986; Seltzer, 1992). In the vicinity of these collection localities solid glaciers remain above 5500 m. The smooth sloping shoulders of the valley walls in Tojoloque, Qanchis Qocha, and Pusu Punku suggest that they too have been recently glaciated, an event that would surely have extirpated local leech populations. Rather than being indicative, then, of relictual populations separated by the Andean orogeny, it would appear that the distribution of these *Helobdella* species is due to dispersal. However, this too raises an awkward problem. It is well understood that blood-feeding leeches, particularly *Theromyzon* species that specialize on waterfowl, may remain attached to their avian hosts long enough to be actively dispersed (Davies and Wilkialis, 1980, 1981). However, *Helobdella* species are predators whose ancestors gave up blood feeding in favor of the coelomic fluids of more readily acquired invertebrates (Apakupakul et al., 1999; Light and Siddall, 1999). Evidence for active dispersal of *Helobdella* species on vertebrates is tenuous at best (Mishra and Chubb, 1969; Daborn, 1976). Davies (1979) was convinced that the existence of *Helobdella* species on Anticosti Island was due to their passively being carried in oceanic currents from the mainland particularly in light of these species being tolerant to hyperosmotic stress (Reynoldson and Davies, 1976). But there are no currents running uphill in the Andes, and the rate and volume of water flow currently observed in the Rio Pelechuco Valley or even higher up in Tojoloque (see fig. 1) would seem to preclude their maintaining position and crawling upstream. Further evidence in this regard is the absence of *H. nunununuojensis* at UU99-11 only 100 m higher, yet separated by a cataract (fig. 1). The complete absence of

Helobdella species in the Rio Pelechuco Valley below also suggests that lower-elevation bodies of water are not the likely source for dispersing leeches. In experimental conditions, Davies et al. (1982) demonstrated that not even one *Helobdella stagnalis* was transferred between two adjacent pools over a 12-day period with 10 adult domestic ducks available for transfer. In that same time the sanguivorous species became randomly distributed in the two pools. Because glossiphoniid leeches brood their young, which cannot survive apart from their parents (Davies and Wilkialis, 1980), dispersal of eggs by wind seems unlikely and would be unlikely to lead to such high local endemism. Survival through the gastrointestinal tract of birds and chance deposition of inseminated adults, or dispersal in the shells of terrestrial snails may be the only explanations left.

The lack of aquatic leeches at the lower altitude examined may be due to the very high rate of flow in the Rio Pelechuco and its tributaries. However, the presence of high levels of mercury in the local rivers as a result of mining operations may also affect leeches that are highly susceptible to heavy metal concentrations (McNicol et al., 1997).

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